REPORT

OF

THE BOARD OF ENGINEERS,

AS WELL AS THAT OF

W. E. LOGAN, ESQ.,

Provincial Geologist,

UPON THE

SURVEY OF LAKE ST. PETER

IN OCTOBER, 1850.

MONTREAL:
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1850.

LETTER OF INSTRUCTIONS,

FROM THE

MONTREAL HARBOUR COMMISSIONERS,

TO THE

BOARD OF ENGINEERS,

APPOINTED TO SURVEY LAKE ST. PETER.

Copy.

MONTREAL, 22nd OCTOBER, 1850.

GENTLEMEN,—Some five years ago, it was determined by the Provincial Government of Canada, to improve the navigation of the St. Lawrence between Quebec and Montreal, so that a vessel drawing 16 feet water, should be able to sail, up or down, in any stage of the water. Mr. Atherton, in 1844, then in the employ of the Provincial Board of Works, surveyed Lake St. Peter, and reported in favor of deepening the present natural channel. This was opposed by the President of the Board, Mr. Killaly, who advised the cutting of a new and straight channel. This plan being adopted, the work was placed under the superintendence of Mr. David Vaughan. While this work was going on, a strong party sprung up, who opposed the construction of this straight channel, which they stated would be unsuccessful, and that at least 600 feet of a breadth, at its upper end, would be required—that for the purposes of the trade, its very straightness was an objection, &c. An outlay of some $320,000 had been made in this new channel, when the Government, on the Reports of a Committee from the House of Assembly, stopped the work in 1846. We would refer you to the Reports of Mr. Atherton, Mr. Young, the Committee of the House of Assembly, Captain Bayfield, and Captain Boxer, R. N.

The deepening of Lake St. Peter, and the improvement of the navigation, between this City and Quebec, is now placed under our control, and we have called on you, as gentlemen of experience in your profession, to examine fully, into the whole matter, and report to us, the best means, of effectually opening a channel, of 16 feet in low water, between this place and Quebec, as well as the cost of opening a channel of 13 feet, 14 feet, and 15 feet.

We have placed at your disposal, two Branch Pilots, Messrs David Bouillie, Branch Pilot No. 2, Zephirin Mayrand, do. do., on whose statements you can rely, and who are practically acquainted with the towing of vessels, and the various channels and places which require dredging. A steamer is placed at your disposal, and you will be supplied with boats, or whatever else you may require in the survey.

The foregoing remarks we believe embrace the plain facts, and as you are now acting as our Board of Engineers, without and entirely unconnected, with local interests or prejudices, we believe you will be enabled to arrive, at a comprehensive result, and give us such a report, with your reasons for your opinions, as shall have weight with those, who may desire to be convinced of their correctness, before advancing, the necessary funds to complete the work, this latter remark, is the more necessary, from the conflicting views which exist on the subject.

We are happy to say that W. E. Logan, Esq., Provincial Geologist, a gentleman of great eminence in his profession, will accompany you, in the hope, that he may be of service in determining, the character and age of the deposite in Lake St. Peter.

We are, Gentlemen,

Yours very respectfully,

(Signed) JOHN TRY, *Chairman.*
" JOHN YOUNG.
" LOUIS MARCHAND.

To General McNeil, Captain Child, and S. Gzowski,

Board of Engineers to Examine and Survey Lake St. Peter.

MONTREAL, 31st October, 1850.

To The Hon. The Board of Harbor Commissioners of Montreal.

GENTLEMEN,—Having accepted the responsible trust confided to us, as your Board of Engineers, we, on the receipt of your instructions of the 22nd instant, proceeded to the discharge of the duties devolved on us, as specified in those instructions.

Accompanied by your President and Secretary, experienced Pilots provided, in fact with every facility essential to the speedy and accurate attainment of our object, we embarked in the steamer Richelieu that afternoon for Sorel—where we had the pleasure to be joined by Mr. Logan and Captain Armstrong, and early the next day, (Wednesday, 23rd,) reached our main field of operations, Lake St. Peter.

Under favorable auspices, the calmness and clearness of the weather, and, consequently, smoothness of the Lake, we commenced soundings with a pole graduated to feet and inches, and making such other surveys, examinations and observations, as, in our judgment, would suffice to disclose with sufficient minuteness, all the facts, to enable us as you desire, "to arrive at a comprehensive result, and to give you such a report, with reasons for our opinions, as shall have weight with those, who may desire to be convinced of their correctness, before advancing the necessary funds to complete the work."

1st.—To ascertain the nature and character of the materials forming the Bars and Flats which obstruct the navigation of the River and Lake, frequent borings were made, and specimens preserved for analysis by Mr. Logan, to whose communication on the subject (hereto appended) we would respectfully refer you; and from the tenor of which it may be confidently assumed, that the flats of the Lake are an alluvial deposit of a very fine clay slightly intermixed with sand, formed by the river drifts of the St. Lawrence, and its subsidiary arms, which meander through the islands and debouche, at the head of the Lake, together with the lateral tributaries, the Rivers Yamaska, St. Francis, and others of less capacity.

It may be inferred, as experience has proven, that material of such description is easily excavated by dredging and the use of the harrow; and yet its consistency is such, that it does not

seem, from previous excavations, to have silted up; obvious, however, would be the necessity of concentrating the several currents, as far as practicable, into one Channel, thereby materially aiding further excavations, and as a permanent security against a re-deposit of obstructions once removed.

2nd.—We proceed to state the direction and character of existing Channels, comparing the soundings and the velocities of currents, of the Old and New Channels with each other as determined by ourselves, and also by Captain Bayfield, R. N, and others.

The facts under this head are summarily exhibited in the following Table:—

TABLE 1st.

Shewing the Soundings taken in the Straight Channel, in the years 1846, 1847, 1848 and 1850; also those in the Old Ship Channel, all reduced to low water of 11 feet on the Flats, the results being the mean depth in cross sections of 150 feet in width, commencing at the head of the cut for the New Channel and at the Upper Bar for the Old.

Soundings.	1846. By Mr. Keefer and Cap. Vaughan.		1846. By Capt. Bayfield, R. N.	1847. By Cap. McKim.		1848. By Mr. Rubridge.		1850. Board of Engineers, 23d, 24th 25th October.		Soundings of Old Ship Channel by Board of Engineers.
1	15	0	Captain Bayfield reports on 17th September, the depth to be at least as much as previously reported, if anything increased. Again that there is no perceptible change in the relative depths of the two Channels, for 16 years, or since his survey of the Lake, in 1830, except at the head of the new Channel, where a considerable portion of the former shallow bank has been cut away by the action of the current, as shewn by the red dotted line on the Chart.	14	7½	15	0	14	2	On the Upper Bar 1st mile, average 15
2	11	9½		13	8⅓	15	0½	13	10	feet, 12½ feet minimum. Thence a deep
3	12	2		13	10½	13	7	13	2	Channel for 3 miles.
4	12	5¾		11	3	11	11	13	3	Thence for 2 miles
5	12	5⅘		11	6⅝	12	10⅞			on the 5th and 6th miles, 11 feet 8½ in.
6	12	5½		12	8¼	13	6⅝	13	10	Thence for 1-2 or
7	12	9½		.....		12	9 5/11	13	9	to the 8½th mile, 11 feet 9½ inches.
8	13	3		13	5⅝	12	3½	13	2	Thence for 1-2
9	12	11⅝		12	6⅝	13	2	13	9	miles, or to the 10th mile, 12 feet 8½ inch,
10	13	5⅝								on 10th mile, 13 feet 9½ inches, 10¾ miles,
11	11	10		12	9⅝	12	10 11/16	13	7	13 feet 3 inches.

The average depth of water in the Straight Channel, for a distance of 2¼ miles from the point to which dredging operations were carried, is 12 feet 9 inches.

The "position of Soundings" by Messrs. Keefer, Vaughan, McKim and Rubidge, is more particularly stated by localities

named by them, answering however very approximately to the distances assumed above by us.

From the foregoing it appears that for a period of five years, from 1846 to 1850, inclusive, the New Channel has, to say the least, generally maintained the depth to which it had been dredged. In fact, it has increased in depth even beyond that represented by the soundings of Mr. Rubidge in 1848, excepting for a short distance at the head of the Channel, where he reports 10 inches to 1 foot more water than we do. This, however, we do not deem material, as we think it easily accounted for from the fact that the excavated *sand* of which that portion of the cut is formed, although displaced in tempestuous weather and by the currents, was yet too heavy to be far removed, and by its gravity was soon deposited where it now is. This seems the more probable, because of the generally increased depth of the Channel below, where the bottom consists, as hereinbefore stated, of a very fine clay, which, when disturbed, does not readily subside, but mingles with the waters, and is carried off by the current; in which supposition we are fully supported by the Report of Mr. Logan, which determined the light and flocculent character of this clay, and which, in our opinion, fully proves, that with proper concentration of currents and the application of mechanical means, in the first instance, to disturb and remove the material, permanency in the depth of any adopted Channel will be secured.

TABLE No. 2.

Exhibits the comparative velocities of the currents in the old and New Channels per mile, per hour:—

Old Channel.	New Channel.
Below the Upper Buoy, 1·58 per mile, per hour.	At the head of New Cut,..... 1·45
Half way between the Lower Light and Buoy,..... ..... 0·67	Lower end,..... ..... 0·59
At Lower Buoy,..... ..... 0·81	One mile above Lower end of Cut,..... 0·54

The velocity of the current at end of Stone Island in the Main Channel, 1 58 per mile, per hour.

It may be satisfactory to append, in connection with the foregoing, the following extract from the Report of Captain Bayfield:

"Although the first cut is incomplete, and has not been carried much below the 6th Buoy, a current of considerable strength has already been established, fully equalling, if not exceeding in rate, that which obtains in corresponding points of the Old Channel, for instance, at the 2nd Buoy of the New Channel, the rate was 1½ Knots, while, at the Upper Light, it was 1¼ Knots; at the 7th Buoy, ⅔ Knots, and at the Lower Light Vessel, ½ a Knot. These facts show that there is no tendency in the New Channel to fill up which is ascribed to the direction of the resultant of the currents of the Main Streams which unite a short distance below Stone Island, and also to the strong current setting to the Southward past the point of the marshes that extend from Monk Island, and lastly, by the action of the current, in cutting away the banks between the red dotted line and the first Buoy, which southerly direction is deemed very important.

"But with reference to the improvement of the Old Channel, it would be unsafe to leave the New Channel open, because the very considerable water now passing through it would lessen the chance of any cut that might be made through it remaining open."

We concur with the above-named justly distinguished authority as to the existence of a current of considerable strength through the straight Channel, and its probable increase, and that there is no tendency to fill up; but we differ with Captain Bayfield in the fact as stated by him, that a greater velocity of current exists in the New than in the Old Channel. We find it otherwise, as stated in the foregoing table, from the obvious fact that from the direction of the waters of the St. Lawrence, whether by the Main Stream, or through subsidiary Channels among the Islands, and the inclination not Southward but Northward at the head of the Lake, and after it has passed the marshes extending below Flat Island, that the greater volume of water would seek an outlet by the Old Channel, and the samecause does operate in favor of the velocity, of current, in the Old Channel throughout, until when, from the influence of currents

from the subsidiary Channels entering the Lake, North of the Main Channel, a Southern inclination from the Lower Light obtains to the junction of the two Channels opposite the River Machiche.

We also agree with Captain Bayfield, that it would be unsafe to leave the New Channel open, in the event of improving the Old one, while the same course of reasoning, will, in our opinion, justly apply to prove the necessity of stopping the Old Channel, should the improvement of the New Channel be decided upon.

In addition to the foregoing considerations, it is proper, before entering upon the estimates of the costs, to announce this principle of concentration of water into our Channel, as the indispensable guide to a conclusion, upon which, we can ourselves rely, and by which, the objects as stated in our instructions, viz.: "The best means of effectually opening a Channel of 16 feet "depth in low water, through Lake St. Peter, as well as the "cost of same, and also the cost of opening a Channel of 13, 14 or 15 feet," can be effectually and satisfactorily secured.

In fact, no one can doubt that much water now flows through both Channels, diminishing the supply in each separately, and as a consequence, if either were closed, the current through, and depth of the other, would be proportionably increased.

In connection then with cost of excavations to deepen either Channel within prescribed limits, we must look to the practicability and cost of effecting such a concentration.

For instance, if we would effectually improve the New Channel, we must direct the waters flowing through the subsidiary Channels into the main Channel of the St Lawrence, and by the construction of dams and jetties, direct the accumulated body of water fairly into it, and also close the Old Channel.

If, on the other hand, the improvement of the Old Channel is to be effected, the same principle of concentration applies; we have but to allow the waters of subsidiary Channels to flow on naturally, for they chiefly come down in the desired direction, and to complete the work of diverting the whole of the main current of the St. Lawrence to throw a groin in a north easterly direction from the Flats of Monk Island, and thence by a dam across the New Channel, to the Bar, North of it.

With these considerations we have the means of instituting a

comparison of the two Channels—or, rather, to determine in what direction it may be advisable in our opinion to make a Channel, answering the conditions specified in our instructions; for, independent of all pre-conceived opinions and local prejudices, we regard either Channel, or both, as but natural features to be availed of, so far only as they may not impair or conflict with the main object—*which object is the making of the best practicable Channel, through the Lake St. Peter.* Unquestionably, one or the other, the Old, or the New Channel, indicates where the Channel in view should be, and to determine which shall be adopted, we proceed to compare them.

It will be shewn that at each and all of the several widths and depths assumed, the Old Channel has greatly the advantage in point of cost; nor does it appear unfavourably on comparison of the soundings or the velocity of currents.

The New Channel being straight throughout, is about three quarters of a mile shorter than the Old, which is termed *crooked* by comparison; but which, nevertheless, is not, from all that we can learn, inconveniently so, as to cause us to attach as much weight to the objection, as obtained in the opinion of many others of high authority. In other words, we are satisfied that were it of the desired depth and width for *large vessels* throughout, the inconvenience alledged would not be experienced. Certainly a New Channel would not be sought as a remedy for obstructions caused by River drift, which may be removed as easily from the one as the other.

In viewing this case *de novo*, we cannot but observe that nature should be aided by artificial means, and not forced from her ordinary course, and with high respect for the opinions of others we must take her suggestions from the present, rather than a very remote past period of time.

Although the Main Channel through the Lake may have once been in the direction of the New cut, yet the interposition by nature herself of the extensive St. Francis bank has for an indefinite period effectually and permanently modified her own work, and produced the present Old Channel, which we think may now be justly called the Natural Channel, it being the deepest, most central through the Lake, and drawing without artificial assistance vastly the larger portion of all the waters of the St. Lawrence River.

Again, the risk of vessels coming in collision at the curves of the Old Channel, or within the New Channel, in consequence of its straightness, seems to us to have been unreasonably magnified.

No Channel can be safely navigated without care, and we know from daily experience that where accidents are most apprehended, they least often occur. It is clear also, that great width of Channel, with moderate crooks, is better, the depth being the same, than a straight and narrow one, as in the present instance. But any improved Channel, however narrow or crooked (far more so than either of these,) may be rendered safe by such regulations as may be established by the constituted authorities—in illustration of which, the River Clyde in Scotland, furnishes a prominent example. Furthermore, the adoption and perfection of the New Channel involves the stoppage of the old one, and thereby, will force the whole trade of the River through the New Channel, thus rendering its enlargement at once to a width of 100 fathoms, absolutely necessary, while the character of the entire bottom of the Old Channel, shewn by Mr. Logan to be lime clay, easily removed by harrowing, relieves that Channel from the difficulties stated, as apprehended by Mr. Killaly from the entanglement of the passing vessels with the buoys, boats and rigging employed on the work. Nine tenths, however, of the bottom of the New Channel, is of the same material as that of the old, and as easily removed by similar means, while the cut through the St. Francis bank, is chiefly coarse and fine sand, which must be taken out by dredging. When thus fully excavated throughout to 100 fathoms in width, and the principal part of the St. Lawrence waters turned therein, the New Channel would doubtless have a slightly stronger current, and be more acceptable to all concerned than the old one. But the above considerations viewed in connection with the estimates will shew if the advantages of straightness, and consequent reduced length will compensate for the greater cost—for from our premises it follows that this difference of cost may be so great as to more than counterbalance the slight curves of the Old Channel. The results of these estimates are as follows in tabular statement:

TABLE OF COSTS.

WIDTH 150 FEET.			WIDTH 300 FEET.			WIDTH 450 FEET.			Depth.
Old Channel Cost.	New Channel Cost.	Difference.	Old Channel Cost.	New Channel Cost.	Difference.	Old Channel Cost.	New Channel Cost.	Difference.	
£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	Feet.
9729 19 0	13665 13 4	3935 14 4	16253 1 4	26457 13 6	10204 12 2	19481 12 1	36166 15 8	14685 3 7	13
16621 16 3	21709 8 6	5087 12 3	25859 18 9	46040 17 1	20180 18 4	32340 11 9	67275 6 10	34934 15 1	14
22303 5 6	36659 14 0	14356 8 6	37225 11 2	70851 0 3	33625 9 1	48104 8 10	97854 17 7	49750 8 9	15
28201 3 10	47898 8 4	19697 4 6	49624 18 10	88205 17 3	38580 18 5	65040 7 0	123852 8 1	58812 1 1	16

Estimates as much in detail as our time will admit, are hereto annexed, and marked A and B:

These results show that at 13 feet depth of channel and of the respective widths of 150, 300, 450 feet, the differences in favor of the Old Channel are £3,935 14 4, £10,204 12 2, and £16,685 3 7. At 14 feet depth £5,087 12 3, £20,180 18 4, and £34,934, 15 1. At 15 feet depth, £14, 356 8 6, £33,625 9 1, and £49,750, 8 9. And at 16 feet depth, £19,697 4 6, £38,580 18 5, and £58,812 1 1. Or the cost by the Old Channel at 16 feet in depth and 300 feet in width is but £1,722 10 6 more than by the New of half that width; and at the same depth and a width of 450 feet the cost of the New, (£123,852 8 1,) would be double that by the Old, (£65,040, 7, 0. In fact any available amount of money will furnish more improved accommodation by the Old than by the New Channel.

Viewing therefore in any aspect of width and depth, we think that the greatly diminished cost of improving the Old Channel more than compensates for its few curves and slightly increased distance.

There are two other considerations worthy of note, one is, that in addition to the diminished cost, a greater volume of water can be diverted into the Old than into the New Channel, and with a far less risk to the stability of the works required to be constructed for that purpose.

2nd.—It has not heretofore been contemplated to dispense with the Old Channel, on the contrary, at the greatest width heretofore proposed for the New Channel, to wit, 300 feet, "that breadth being sufficient for the special and principal purpose of "enabling ships of heavy draft in tow of steamers to pass the "Lake." Rafts are to be forbidden its use, "lest they should "injure the buoys, or get in the way of vessels," neither is it to be used by night, "the present ship Channel remaining sufficient *for the general purposes of trade.*"

If then as we have asserted, as much water as can be practically and with ease accumulated should be thrown into one Channel, and hence the propriety of closing the other; and 300 feet width be not sufficient for the general purposes of the vast trade destined to seek the St. Lawrence as its favored avenue, it follows that a wider Channel is advisable; and we on mature deliberation recommend 450 feet as the proper width of the contemplated Channel to be excavated to the depth of 16 feet.

Such dimensions naturally point to the Old Channel, which for a distance of about five miles, presents a superabundant width and depth of water, and for the remainder of its extent is as easily to be widened and deepened as the corresponding part of the New Channel; and for this and other reasons stated, we are of opinion that you should *adopt the Old Channel* for improvement and shut up and abandon the New. We cannot perceive any cogency in the argument that more money should be spent to attain an object for which much has already been ineffectually expended, when, as in the present instance, a less sum applied in another direction will attain that object.

We estimate that three steamers of 150 horse power each, with properly constructed harrows as large and heavy as can be drawn five to six miles the hour will produce 13 feet depth of water in the Old Channel 450 feet wide, throughout, in one season's work, from the opening to the close of navigation,—also that 14 feet depth will require the same power two seasons; 15 feet depth three seasons, and 16 feet depth from years.

The same ultimate effect could not be produced in the New Channel in a less period than six years.—

The improvements of the navigation below Lake St. Peter, namely, on the *Poulier* and English Bars require for the present in our opinions no further expenditure than the placing of buoys designating the position of the Bars, but it may be advisable at some future period to make a wide passage through the English Bar, which will admit of vessels taking a direct course.

At Isle Platte there are two Bars—one extending for a distance of 343 feet—the other for a distance of 1666 feet.

The proper way of permanently improving the navigation at those points is to dredge a channel of six hundred feet in width to a depth of 16 feet, the estimated cost of such a work will be £2075.

The material to be removed on these Bars consists of soft clay and sand, and at a short depth below the surface the clay is of the same description as that found in Lake St. Peter, and may be removed by Harrows.

The economy and success of hydraulic works, such as from the subject of this investigation, especially require the superintending care of a scientific and experienced Engineer, and as it

is far cheaper in the end to employ skill already acquired, rather than incur the mistakes and current losses, of teaching, we recommend that these improvements, when resumed, be placed in charge of a competent Civil Engineer and an experienced Assistant, the latter of whom shall reside constantly on the work.

Having been informed that considerable piling had been done north of Flat Island, to divert water into the New Channel, we were led to look into the condition of the work constructed, and its effect upon the current, but found that nearly the whole had been destroyed—probably by the ice; we therefore present the annexed section and plan of a Piled Dam, such as we believe will be both cheap and durable.

The Piles being deeply driven into the bottom of the Channel, and sunk at least two feet under the surface of low water, and supported by banks of earth and stone, (as represented in the section,) thereby giving the ice room to form, and pass over the Dam.

In conclusion, although it does not come within our province as Engineers, yet we cannot, in connection with the subject, but naturally advert to the immense and growing interests to be accommodated and promoted by any and every improvement of the St. Lawrence, nor do we know of any more important than that which you now contemplate.

The St. Lawrence—the natural outlet of the great Lakes—and they connected by Railroads and Canals with the Ohio and the "Mother of Waters, the Mississippi," the great, the "far West," is directly and largely interested in its unobstructed navigation, and to an extent that must insure, at an early period, its safe, unobstructed and free passage.

To this condition it will, ere long, come, for it does not consist with right or reason, or the enlightened spirit of the age, that obstacles be permitted to exist against the will and interests of the Commercial world.

We have the honor,

Gentlemen,

With the highest respect, to remain,

Your obedient servants,

WM. GIBBS MACNEIL.
JOHN CHILD.
S. GZOWKSI.

Copy.

STEAMER "RICHELIEU," St. LAWRENCE RIVER,
October 21st, 1850.

To W. E. Logan, Esq., F. G. S., Provincial Geologist.

SIR,—Having accompanied us during the past week in our examination of Lake St. Peter, for the purpose of determining the best mode of deepening the Ship Channel through said Lake, and having witnessed the measurements, water soundings and bottom borings in the two principal channels and elsewhere, we shall now be glad to receive from you, in writing, such information as you can readily give on the following points.

1st. The analyses of the following specimens obtained, namely, one from Isle Platte, and two from the New Channel, being one from the head, and one from a mile above lower end; three from the Old Channel, namely, from Upper Bar, Lower Light and Buoy, and one from the English Bar near Pointe du Lac.

2nd. The nature or origin of the formation from which these specimens have been taken.

3rd. Your opinion relative to the effect of the present or moderately increased currents upon the materials constituting the Flats, Bars and Channels of the Lake.

With the highest respect,
We are,
Your most obedient servants,
(Signed) WM. MACNEIL,
" JOHN CHILD,
" S. GZOWSKI,

Board of Engineers appointed by the Montreal Harbor Commissioners for the examination of Lake St. Peter.

MONTREAL, 30th October, 1850.

GENTLEMEN,—In compliance with the wish expressed in your communication of the 28th. instant, I beg to state the results of such mechanical analyses as the time has permitted, of the specimens to which you allude, obtained in your borings in the bed of Lake St. Peter, and neighboring parts of the St. Lawrence.

1. From the Bar of Isle Platte. The bottom of the River in this part appears to consist of clay with a thin and probably partial coating of silicious gravel occasionally mingled with sand. The auger was with difficulty made to bore 3 feet of the clay, and the specimen obtained gives, after drying, 3 per cent of sand, the remainder being nearly pure clay.

2. From the Upper Bar in the Old Channel. The bed of Lake St. Peter is here a soft, argillaceous mud, through which the auger was pressed without difficulty to the depth of 12 feet. The material is a blue nearly pure clay. The depth of water was here 14 feet—the rate of current in miles and decimal parts 1·51.

3. From the Lower Light Ship. The bottom in this part is exactly the same as in the previous instance. The auger was without exertion pressed through 14 feet, and the material is a nearly pure clay. The depth of water was 13ft. 2 in. the rate of current 0·91m.

4. From the Lower Buoy. The bottom here much resembles that in the last two instances. The weight of one man was sufficient to press the auger through 13½ feet of the deposit, of which the first six inches appeared to be rather tougher than the remainder. The material in the lower part is a nearly pure clay. A specimen taken midway between the Lower Light Ship and the Buoy, another two miles below the Buoy, and a third four miles further down give nearly the same results. In the three cases the auger with little pressure sank over 13 feet in the mud. The depth of the water at the Lower Buoy was 14 feet; the rate of current 0·81m.

5. From the head of the New Channel. In this place the bottom consists of sand; the auger was with difficulty worked through 5¾ feet, the top of which holds 48 per cent of clay, the bottom 17 per cent of the same, the remainder in each case being coarse sand. The larger quantity of argillaceous material at the top appears to arise from the presence of a thin stratum of clay overlaying the sand. The depth of water was 15ft. 3in.—the rate of current 1·45m.

6. From a point about a mile and a half above the lower end of the New Channel. The bottom here is nearly the same as in the instance of No. 4. The borer sank with little pressure through

11 feet. The first six inches were rather tougher than the remainder; they gave a clay with 8 per cent of sand; the remainder is a nearly pure clay. A specimen taken a little higher up in the New Channel, and another from the lower end, give nearly the same results. At the lower end of the New Channel the depth of water was 14ft. 4in.—the current 0·59 m. per hour.

7. From the Upper or *Poulier* Bar near Pointe du Lac. The bottom here consists of tough clay, through which the borer was with difficulty worked 2½ feet. The Lower or English Bar near Pointe du Lac has a covering of gravel on which the borer had no effect; but from its proximity to the Upper Bar, it seems propable that this gravel is underlaid by a similar clay, and that a partial coating of gravel will be found to invest the Upper Bar. On the *Poulier* Bar the depth of water was 18 feet,—the rate of current 1·17 m. On the English Bar the water was 15½ feet—the rate of current 0·99 m.

On desiccation, the nearly pure clays (which still hold a minute portion of fine sand not separable by any ordinary process of washing) have the aspect of pottery clay, or fuller's earth, and when rubbed with the nail or cut with a knife show a glossy surface, unctuous to the touch. In the deposits they are in a condition of very minute division; in those instances in which the auger sank with facility to the various depths mentioned, there is of course a large portion of water associated with the clays. In this state they are by agitation readily mingled with an increased amount of the liquid; and on experiment an ounce of the clay, thus mixed with about thirty times its bulk of water, and left to subside in a vessel in which the mixture occupied a height of 8 inches, (and in which the clay, if pressed into a solid mass, would not present a thickness of more than a quarter of an inch,) after resting twenty four hours, still remains suspended to the height of three inches in so very light and flocculent a condition, with two and a half inches of opaque, turbid water over it, and half an inch of clearer liquid above, that the most gentle current would be sufficient to float it away.

The argillaceous deposits of the Lake, notwithstanding their softness, are in most places, and in the New Channel more than in the Old, covered with a skin holding a small and varying amount of sand which gives it a sufficient degree of tenacity to

resist the wear of the present currents, and it seems to me probable that once brought to a quiescent state, and thus protected, the deposits would resist even moderately increased currents, where the bottom is free from abrupt inequalities of surface in their direction, but that the skin broken and the deposits by any means disturbed and agitated, so as to bring them into suspension, such currents would be sufficient to carry the great bulk of the material to considerable distances. According to the best authorities, a velocity of three inches per second or 900 feet per hour at the bottom will just begin to work upon fine clay fit for pottery, and however firm and compact it may be, it will eat away the surface; yet no beds are more stable than those clays when the velocities do not exceed the rate indicated, for the water soon takes away the impalpable particles of the superficial clay, leaving the particles of fine sand, usually associated with it, sticking by their lower half in the rest of the clay, which they now protect, making a very permanent bottom, if the stream does not bring down gravel or coarse sand, which will rub off this very thin crust and allow another layer to be worn away. A velocity of six inches per second will lift fine sand ; eight inches will carry off sand as coarse as linseed ; twelve inches will displace fine gravel, and twenty four will roll along rounded pebbles, of an inch diameter; to carry away angular fragments of stone as large as a hen's egg requires a rate of three feet per second.

With the exception of the various Islands and their reed-producing prolongations, constituting the delta at the head of the Lake, several of which appear to be composed of sand, it is very probable nearly the whole bed of the Lake will be found to consist of the soft argillaceous mud which has been described. In some of the borings in this, fragments of one or two species of shells, at present inhabiting the river, were met with near the surface, and at depths of seven and eight feet, shewing that the deposit is the drift of the river. The argillaceous mud was met with also in some of the numerous Channels which intersect the sandy Islands, leading to the inference, which, however, requires confirmation, that the clay may extend under the sand. Fragments of river shells were found associated with the sand also, so that whether it be over or under the clay, it is

alluvial; and it would thus appear that no parts of the deposits of Lake St. Peter and its Islands are the remains *in situ* of those clays and sands of ancient marine origin, which form a large portion of the immediate valley of the St. Lawrence, and through which the main river, and many of its tributaries have cut their way for considerable distances. It is from the ruins of these marine beds however of the post tertiary period, brought down by the tributaries and the main river, that the alluvial deposits of the Lake are supplied. To pursue the material carried from each or any individual tributary, and point out its distribution, and the effect it may have on the waters of the main stream, would require a much more extended investigation than the present; but it does not appear to me to follow as a matter of course, that because a deposit is near the mouth of a tributary, it is of necessity derived from it. To ascertain, for example, whether the material of the sand bank out in front of the mouths of the Rivers Yamaska and St. Francis, is supplied by them, would require an examination into the nature and quantity of the sediment brought by them during freshets, and under other circumstances; and the force and direction of the currents then, and at other times prevailing. This bank is a subaqueous continuation of Monk Island, the whole of which Island is above the mouths of those streams, and cannot therefore be derived from them; and though it is not an improbable supposition that they may have contributed to the material of the subaqueous part, it is not impossible, also, that it may be due to a continuation of the supply, which formed the Island higher up. But whencesoever the sand is derived, there seems little doubt that the St. Lawrence current in the Ship Channel on the one side, and the currents of the tributaries on the other, have arranged and modified the form of the bank, and that this has reacted on the currents. It is probable that what is called the Ship Channel once ran from Monk Island straight through the Lake, as it appears from Bayfield's soundings in 1831 there were then traces of it lower down; but the transverse action of the tributaries has so modified the distribution of the material as to produce a deflection of the St. Lawrence current in the Channel in question, and carry it into what is called the Old Channel.

In respect to the soft argillaceous deposits, all the rates of current ascertained being greater than that sufficient to give to the bottom current the velocity required to remove fine clay, it may be asked by what cause such a retardation of the rate has at any time been effected, as to permit the clay to come to a state of rest. According to what has been stated, the clay would fall at any velocity under three inches per second; this is understood to be French measure. A bottom current of 3 inches per second would represent a surface velocity of 7·463 inches French per second, or expressed in English miles and decimal parts, 0·47 per hour. The lowest rate of current ascertained was 0.54 at a mile and a half above the lower end of the New Channel. But in the Old Channel, midway between the Lower Light and Buoy, two trials were made in one spot on different days. In the first instance the rate was 0.67, and we were informed by the light-man that the water was at the time six inches higher than it had been some hours before, in consequence of the effect of tide. In the second instance, the rate was 0·73, when we were informed it was low water, the light-man's guage shewing six inches less than on the previous trial. That the lower rate with the higher water was a tidal result, is evident from the fact that if the water had risen from increased supply, the current should rather have been stronger than weaker, unless the Channel at the entrance could not carry off the increased supply so fast as the Channels at the head gave it, which does not appear probable. If 0·70 be taken as the current when the slope of the river is unaffected by the tide, the retardation produced by an ordinary tide would appear to be between 4 and 5 per cent., and perhaps it is not assuming too much to suppose that some occasional combinations of tidal and fluviatile conditions, such as extraordinary high tides, and general low water in the river, with the temporary influence of wind, may effect a retardation of a quarter of a mile per hour, which is about the amount that is required.

I have the honor to be,
With much respect,
Your most obedient Servant,
(Signed,) W. E. Logan.